LESSON 8: DETERMINING LOCATION

PURPOSE

In this chapter, we have presented most of the basic map reading skills. However, skills such as determining an eight-digit grid coordinate, and locating an unknown point using **polar coordinates**, **intersection**, and **resection** will help you to more accurately locate and plot points on a map. This lesson examines those skills and gives you an opportunity to practice them. We will also show you how to determine direction using a **field-expedient** method.

field-expedient
intersection
polar coordinates
resection

INTRODUCTION

Sometimes it is not enough to know how to locate a point to within 1,000 or 100 meters, or to estimate the location of a distant point on the ground. There may be times when you have to determine your location, or a distant point, even more accurately. Or, perhaps you will need to use certain known locations as reference points. This lesson will help you to accomplish these tasks.

DETERMINING AN EIGHT-DIGIT GRID COORDINATE

To determine an eight-digit coordinate, you must use a coordinate scale. Keep in mind that there are 100 meters between each 100-meter mark (number) on the coordinate scale, with a short tick mark to indicate 50 meters between each 100-meter mark. To locate *Spot elevation (SE) 450* in Illustration 2.8.1 to within 10 meters, use the following procedures:

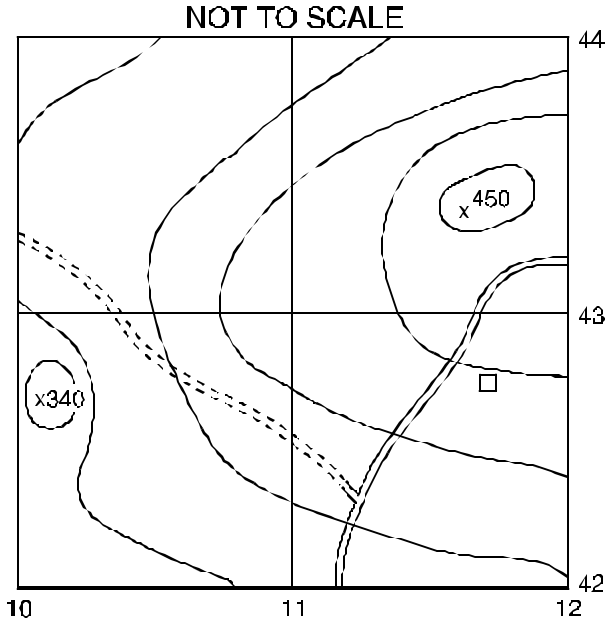

Illustration 2.8.1

1. Recall that you must first identify the 1,000 meter grid square in which the spot elevation is located. To do this, remember the first cardinal rule of map reading: *read right, then up*. When reading a map right and up, each north-south grid line increases in value from west to east, and each east-west grid line increases in value from south to north.

By reading right, the last north-south grid line before reaching the grid square containing *SE 450* is 11.

By reading up, the last east-west grid line before reaching the grid square containing *SE 450* is 43.

By adding the 100,000 meter square identifier (YF), YF1143 locates *SE 450* to the nearest 1,000 meters.

2. Next, place the coordinate scale parallel to and directly on top of grid line 43 with the "0 mark" at the lower left-hand corner of grid square YF1143 (see Illustration 2.8.2). (**Note:** Ensure that you are using the correct scale.)

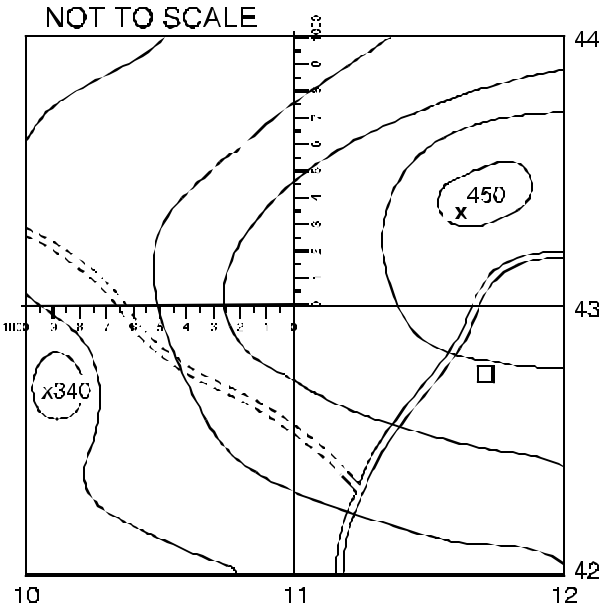

Illustration 2.8.2

3. Keeping the horizontal scale on top of the 43 grid line, slide the scale to the right into the grid square until the vertical scale intersects the center of mass of *SE 450* (see Illustration 2.8.3).

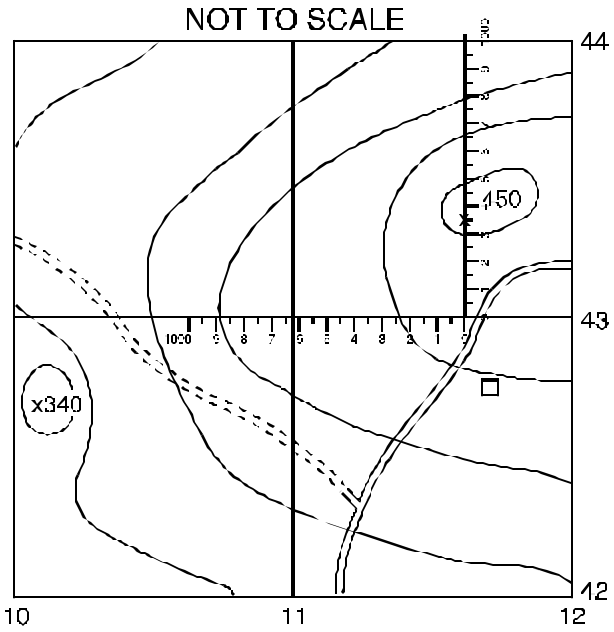

Illustration 2.8.3

4. Now, reading from the "0 mark," the *right* reading shows that *SE 450* lies between the 600 and 650 meter mark by approximately 30 meters. (**Note**: You determine that it is approximately 30 meters by estimating how many 10s *SE 450* is beyond the 600-meter mark. In this case, there are three, which gives you the third and fourth digits of the coordinate. Thus, the center of mass of *SE 450* is 630 meters into the grid square and we would read this number as 1163.

5. Reading *up*, you can see that *SE 450* lies midway between the 300 and 400 meter marks, or 350 meters into the grid square. Therefore, the up reading is 4335.

6. By combining both sets of numbers and adding the 100,000 meter square identifier, the location of *SE 450* is YF11634335. You have now correctly located a point to the nearest 10 meters.

To trace the degree of accuracy of an eight-digit grid coordinate from 1,000 to 10 meters, we can break it down as follows: (1) the underlined numbers in YF11634335, represent the 1,000 meter grid square and they locate the point to within 1,000 meters, (2) the third and seventh digits of YF11634335 denote 600 and 300 meters and locate the point to within 100 meters; and (3) the fourth and eighth digits of YF11634335 denote 30 and 50 meters and locate the point to within 10 meters.

INTERSECTION

You can use intersection to locate an unknown point by determining where the azimuths from two (preferably three) known positions on the ground intersect. There are two ways to determine intersection, the map and compass method and the straightedge method.

MAP AND COMPASS METHOD

The first way to find an unknown point by intersection is with a map and compass. Follow these procedures and Illustration D.

1. Orient the map using the compass.

DID YOU KNOW?

The best way to orient a map is to use a compass.

2. Determine the grid-magnetic angle (G-M angle) of the map you are using. *In this example, the G-M angle is 5 degrees east*.

3. Locate and mark your first known position *(Point A)* on the map.

4. Measure the magnetic azimuth to the unknown point from Point A using a compass. *In this example, the magnetic azimuth is 71 degrees*.

5. Convert the magnetic azimuth to a grid azimuth. *In this example, 71 degrees plus 5 degrees equals a 76-degree grid azimuth.*

6. Place the coordinate scale on the map, ensuring that the zero-degree indicator is at the top and the index point is directly over the center of mass of Point A. Place a tick mark at *76 degrees* on the map. Draw a line from Point A along this grid azimuth.

7. Move to *Point B* (the second known point) and locate it on the map. Then, repeat steps 4, 5, and 6. *For this example: (1) The magnetic azimuth in step 4 from Point B to the unknown point is 35 degrees. (2) Convert this to a grid azimuth using the formula 35 + 5 = 40 . (3) Place a tick mark at 40 degrees on the map and draw a line along that grid azimuth.*

8. The location of the unknown position is where the lines cross on the map. Determine the eight-digit grid coordinate for this position.

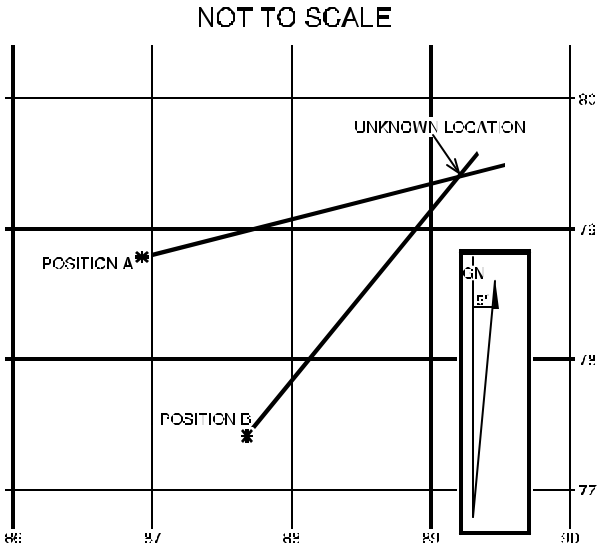

Illustration 2.8.4

STRAIGHTEDGE METHOD

The second way to locate an unknown point by intersection is by using a straightedge. Follow these procedures and Illustration 2.8.5.

1. Orient the map (on a flat surface) to the ground by terrain association.
2. Locate and mark your known position on the map (*Point A*).
3. Place a straightedge on the map with one end at your position (*Point A*) as a pivot point. Rotate the straightedge until the unknown point (*C*) is sighted along the edge.
4. Draw a line along the straightedge.
5. Repeat steps 3 and 4 with the second known position (*Point B*) and check for accuracy.
6. The intersection of these lines on the map is the location of the unknown point (C).
7. Determine the six or eight-digit grid coordinate (depending upon the desired degree of accuracy) for the unknown point.

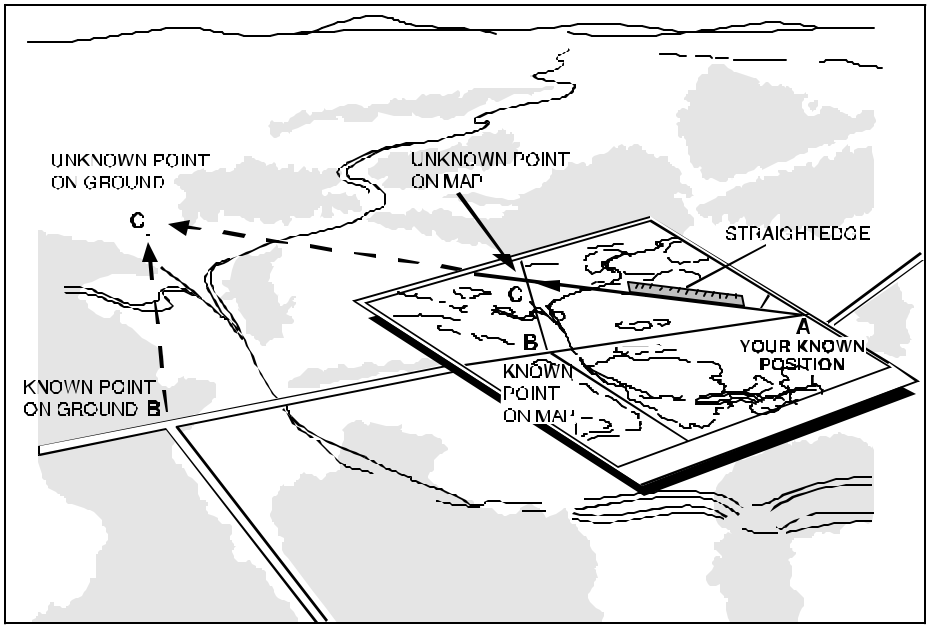

Illustration 2.8.5

RESECTION

You can use resection to locate your unknown position on a map by determining the grid azimuth to at least two well-defined locations on the map. For greater accuracy, the desired method of resection would be to use three well-defined locations. There are three ways you can use resection: the map and compass method, modified resection, and the straightedge method.

MAP AND COMPASS METHOD

The first way to find your unknown location by resection is with a map and compass. Follow these procedures and Illustration 2.8.6.

1. Orient the map using the compass.
2. Determine the grid-magnetic angle (G-M angle) of the map you are using. *In this example, the G-M angle is 3 degrees east*.

3. Identify two or three known locations on the ground; mark them on the map *(such as Hilltop 408 and the control tower)*.

4. Measure the magnetic azimuth to one of the known positions from your location using a compass. *In this example, the magnetic azimuth to Hilltop 408 is 312 degrees*.

5. Convert the magnetic azimuth to a grid azimuth. *In this example, 312 degrees plus 3 degrees equals a 315-degree grid azimuth.*

6. Convert the grid azimuth to a back azimuth by adding or subtracting 180 degrees. *In this example, 315 degrees minus 180 degrees equals a 135-degree back azimuth*.

7. Place the coordinate scale on the map, ensuring that the zero-degree indicator is at the top and the index point is directly over the center of mass of the known point. Place a tick mark at 135 degrees. Draw a line on the map from the known position back toward your unknown location.

8. Repeat steps 4, 5, 6, and 7 for the second known position (*the control tower*). *For this example: (1) The magnetic azimuth to the control tower is 15 degrees. (2) Convert this to a grid azimuth: 15 + 3 = 18. (3) Convert this to a back azimuth: 18 + 180 = 198. (4) Place a tick mark at 198 degrees on the map and draw a line back toward your unknown location*.

9. The intersection of these two lines is your location. Determine the eight-digit grid coordinate for your position.

Note: You can use *modified resection* to locate your position on the map when you are at a linear feature on the ground, such as a road, canal, stream, etc. To do this, you need only one known location. Use the first seven steps above, then where the drawn line (in step 7) crosses the linear feature is your location.

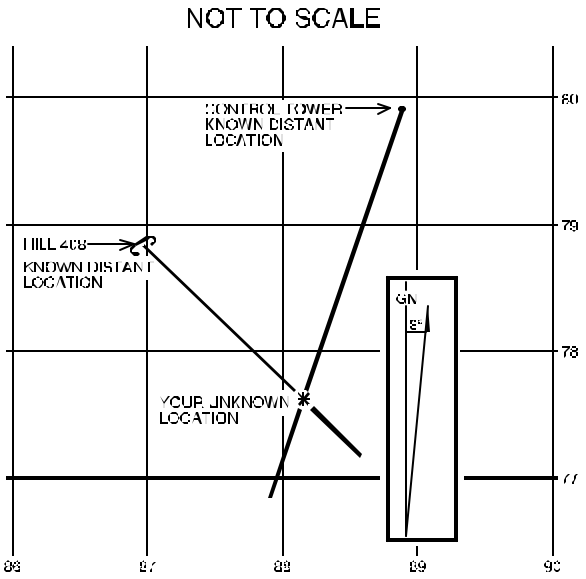

Illustration 2.8.6

STRAIGHTEDGE METHOD

Another way to locate your unknown position by resection is by using a straightedge. Follow these procedures and Illustration 2.8.7.

1. Orient the map (on a flat surface) to the ground by terrain association.

2. Locate at least two known distant locations or prominent features on the ground and mark them on the map (*Points A, B, and C*).

3. Place a straightedge on the map pointing toward one of the known points (*Point A*). Rotate the straightedge until the known point on the map is aligned with the same known point on the ground.

4. Draw a line along the straightedge away from the known point on the ground toward your position.

5. Repeat steps 3 and 4 using the other known points (*Points B and C*).

6. The intersection of these lines on the map is your location.
7. Determine the six or eight-digit grid coordinate (depending upon the desired degree of accuracy) for your location.

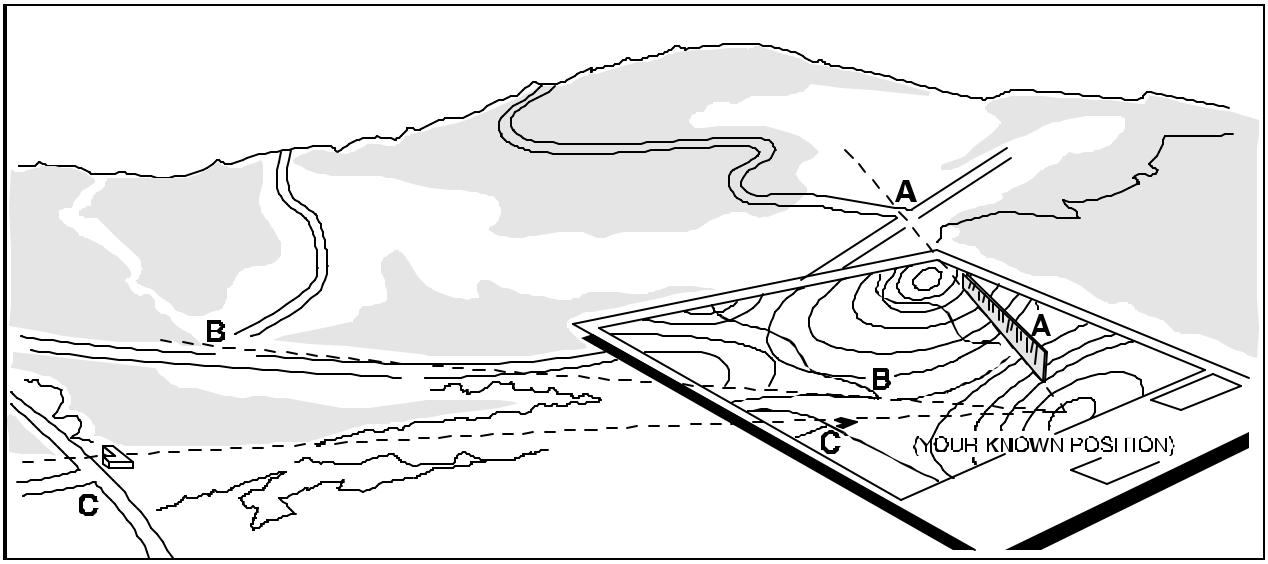

Illustration 2.8.7

POLAR COORDINATES

You can use polar coordinates to locate or plot an unknown point from a known location by giving a direction and a distance along the direction line. Three elements must be present to use polar coordinates: a known location on the map, an azimuth (grid or magnetic), and a distance (normally in meters). There are two ways that you can use polar coordinates, the map and compass method and the protractor method.

MAP AND COMPASS METHOD

Use the procedures below and Illustration 2.8.8 for the map and compass method.

1. Orient the map using a compass.
2. Determine the grid-magnetic angle (G-M angle) of the map you are using. *In this example, the G-M angle is 0 degrees*.
3. Identify the known location on the ground and mark it on the map. *In this example, the known location is the water tank in grid square FL4526*.
4. Measure the magnetic azimuth to the unknown point (*a building in grid square FL4729*) from the known location using a compass. *In this example, the magnetic azimuth to building is 24 degrees*.
5. Convert the magnetic azimuth to a grid azimuth. *In this example, 24 degrees plus 0 degrees equals a 24-degree grid azimuth.*
6. Place a coordinate scale on the map, ensuring that the zero-degree indicator is at the top and the index point is directly over the center of mass of the known point. Place a tick mark at 24 degrees. Draw a line on the map from the known location along this grid azimuth until it intersects the building.

7. Determine the distance to the unknown position. *Using a straightedge and the procedure for measuring straight line distance, you determine the distance to the building in grid square FL4729 to be 3,600 meters*.

PROTRACTOR METHOD

The second way to locate or plot an unknown point from a known location using polar coordinates is the protractor method. Follow these procedures below and Illustration 2.8.8.

1. Determine the location of a known point on the map to within 100 or 10 meters. *In this example, the known location is the water tank at grid coordinates FL45952610*.
2. Measure a grid azimuth to the desired location or destination (the building in grid square FL4729). *By using your protractor, you determine the grid azimuth to be 24 degrees to the building*.
3. Determine the distance as you did in step 7 of the map and compass method.

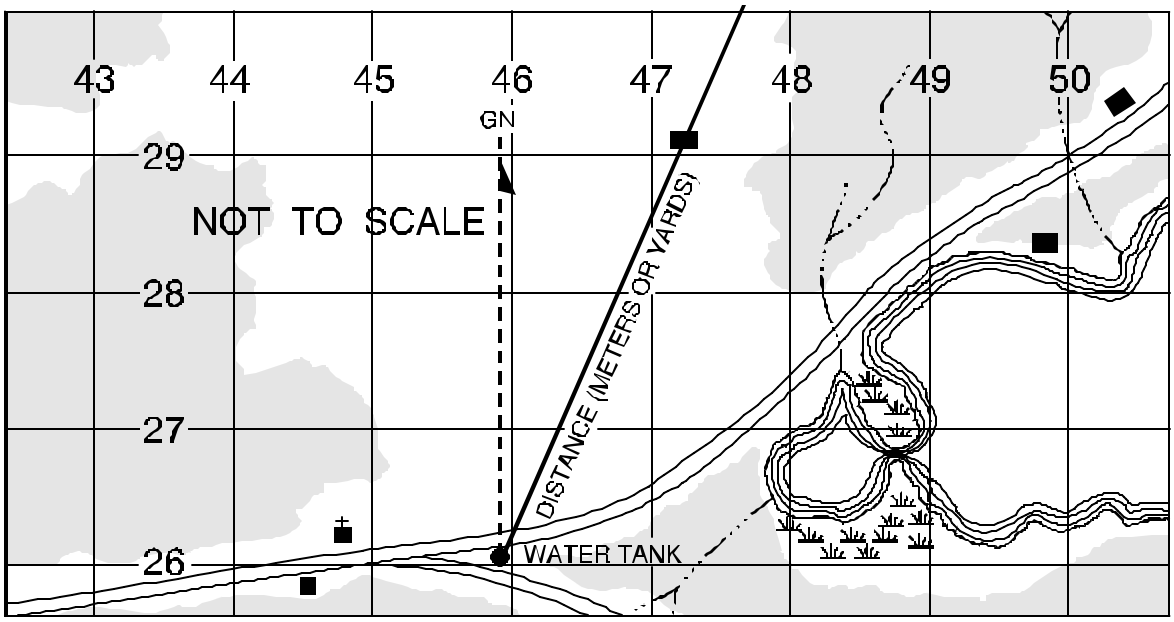

Illustration 2.8.8

DETERMINE DIRECTION USING FIELD-EXPEDIENT METHODS

SHADOW-TIP METHOD

The five easy-to-follow steps explained below will show you how to use the shadow-tip method to determine direction and/or orient a map without a compass.

1. Place a stick or branch (at least 12 inches long) vertically into the ground at a fairly level spot where the sun will cast a distinct shadow. Mark the shadow tip on the ground with a small stone, twig, or other means. See Illustration 2.8.9.

Note: If the tip of the shadow is difficult to find, tap the end of the stick; the movement of the shadow will help you locate it.

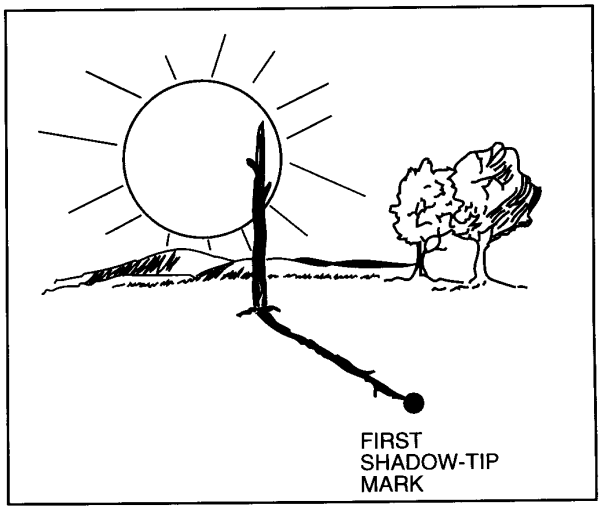

Illustration 2.8.9

2. Wait about 10 or 15 minutes until the shadow moves a few inches. Mark the new position of the shadow tip in the same way as the first. See Illustration 2.8.10.

3. Draw a straight line through the two marks to obtain an east-west line. Extend this line past the second mark. See Illustration 2.8.10.

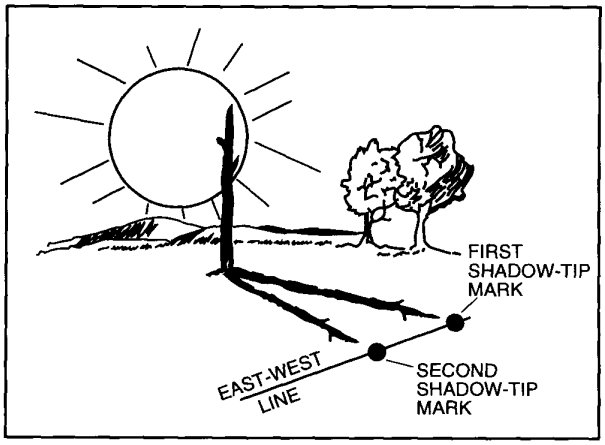

Illustration 2.8.10

4. Determine which is the east end of the line and which is the west end using these tips: (1) the sun rises in the east and sets in the west, (2) the shadow tip moves in the opposite direction, and (3) the first shadow tip mark is always west, and the second mark is always east.

5. To find north and south, draw a line at a right angle to the east-west line at any point (see Illustration 2.8.11). From this north-south line, you can now orient your map and determine the direction you want.

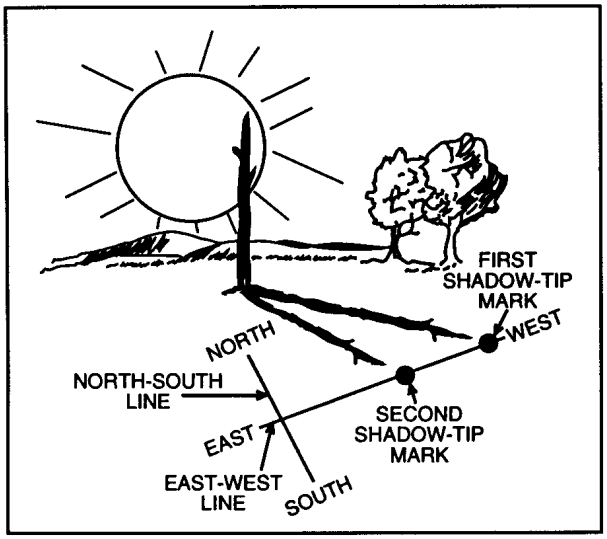

Illustration 2.8.11

WATCH METHOD

You can also use a watch to determine the approximate true north or true south; however, this method can result in errors, especially in the lower latitudes, and may cause circling.

In the *northern hemisphere*, point the hour hand toward the sun. Find a north-south line midway between the hour hand and 12:00 o'clock, standard time. If on daylight saving time, find the line between the hour hand and 1:00 p.m. If you have any doubt as to which end of the line is north, remember that the sun is in the east before noon and is in the west after noon (see #1, Illustration 2.8.12).

In the *southern hemisphere*, point the 12:00 o'clock dial toward the sun, and halfway between 12:00 o'clock and the hour hand will

be a north-south line. If on daylight saving time, the line will lie midway between the hour hand and 1:00 p.m. (see #2, Illustration 2.8.12).

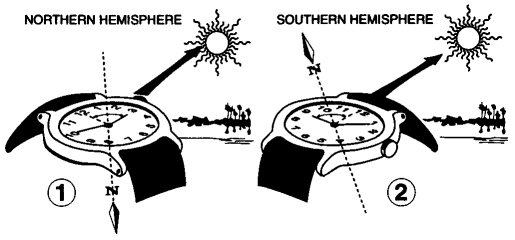

Illustration 2.8.12

GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a high-tech worldwide radio-navigation system formed from a network of 24 satellites and their ground stations. GPS is the first system to pinpoint such a precise location for any point on the globe, during any kind of weather. This system utilizes these satellites to calculate positions down to a matter of meters. As a matter of fact, use of advanced forms of GPS can pinpoint locations down to a centimeter. GPS receivers have become more economical and, therefore, accessible in recent times. Uses of the GPS system include: air navigation, mapping, pinpointing locations, and navigating routes for cars and boats.

A GPS receiver uses the travel time of radio signals to measure distance. The satellites are closely monitored so that their exact location is always known. Any delays created by the radio signals traveling through the atmosphere are corrected.

CONCLUSION

In this chapter, we showed you how to determine a point on a map to within 10 meters using an eight digit coordinate; locate an unknown point using intersection, resection, and polar coordinates; and determine direction using two field-expedient methods.

By using these skills in conjunction with the other map reading skills that we have presented in the previous lessons, you should be capable of finding your way regardless of the situation. You may even have the opportunity to test your skills on an orienteering course (as explained in the next chapter) or on another form of a land navigation course.

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